PROPORTION OF TARGET AND NON TARGET SPECIES IN SELECTED MESH SIZES OF GILLNET FISHERY ALONG MUMBAI COAST OF MAHARASHTRA

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ABSTRACT
The present study on the proportion of target and non target catch in gillnet fishery from three sectors of gillnetters viz., inboard motor (IBM), outboard motor (OBM) and non-motorised gillnetter was conducted during December 2010 - November 2011 at Cuff Parade, Versova and Mahim of Mumbai coast respectively. Altogether six non target species in mesh size (12 and 14 mm), 23 species in mesh size (48 and 50 mm) and 18 species in mesh size (32 and 34 mm) were caught in selected mesh sizes targeted for white sardine (*Esculosa thoracata*), oil sardine (*Sardinella longiceps*) and catfish (*Arius* spp.) in OBM, IBM and non motorised gillnetters respectively. It was found that maximum target catch was observed in mesh sizes of 32 and 34 mm operated for *Sardinella longiceps* (oil sardine) fishery, while least was found in mesh size of 48 and 50 mm operated targeting *Arius* species.

INTRODUCTION

The term 'non target' is usually used for fish caught unintentionally in a fishery while intending to catch other fish. Bycatch is of different species and undersized individuals of the target species or juveniles (Alsayes *et al.,* 2009). These are either kept to be sold or discarded. Reduction of wastage in fisheries is a major goal of most fisheries organizations. However, there is a paucity of information available on bycatch associated with gillnet fisheries and what data is available is inconsistent in India (MRAG, 2012). More than fish and shell fish there are reports that gillnets accounted 76.5% accidental catch of turtles along the Indian coast during 1985-1995 (Rajagopal *et al.,* 1996). Compared to trawl nets, in gillnets, the capture of non target species is lesser (Thomas *et al.,* 2005). In India, the bycatch problem is more due to the multi-species nature of the tropical fisheries. So there is a need to assess bycatch impacts of fishery on stocks and ecosystems to identify and quantify the rates of retained and discarded catches from the different types of gillnets used in Mumbai coast for commercial fishery.

The juveniles are the future adult stock which play vital role for availability and maintenance of every future fish stock. In many developed countries, the non target catches and juveniles are discarded in the sea, whereas, in the developing countries like India, at least part of the non-target catches and juveniles are also brought to the shore (Najmudeenand Sathiadhas, 2008). The ratio of undersized fishes to the catches is huge in a multispecies fishery where various kinds of gears

are competitively employed to target different varieties of fishes (Sivasubramaniam, 1990; Sujatha, 1996). The recent changes in the fishing methods employed in inshore fisheries of the country has led to a remarkable increase in fish production leading to the increasing, problem of by-catch and targeting of juvenile fishing (Radhakrishnan *et al.,* 2006).

Maharashtra with 720 km of coastline along five maritime districts is an important maritime state with respect to marine fish production. The marine fish landings in Maharashtra during 2011 have been estimated provisionally at 4.13 lakh t of which gillnets contribute 11.2% of the total catch and 12,154 mechanised and 2,292 non-mechanised fishing units are in operation in the state (Anon, 2012). Mumbai district alone contributed 1.43 lakh t viz., 32% of the total marine fish production of Maharashtra (Anon, 2011).

The present study was designed to deal with quantitative data of target and non target catch of gillnet fishery operating along Mumbai coast. The data given may contribute in understanding the destructive impacts of inappropriate mesh sizes in gillnets on the fish population at the study area.

MATERIALS AND METHODS

The paper deals with the proportion of target and non target catch in the selected mesh sizes to observe the effect of mesh size on catch characteristics.Samples were taken fortnightly from OBM, IBM, and non-motorised gillnetters from each selected landing centre viz. Versova, Cuff Parade and Mahim respectively to assess the target and non target catch of the

selected mesh sizes. Polyamide (PA, nylon) monofilament gillnets with 0.16-0.23 mm diameter having a fishing height of 3.5 to 7 m and mesh sizes 32 and 34 mm and rigged with a hanging co-efficient of 0.52 targeting oil sardine (*Sardinella longiceps*) were selected for IBM gillnetter. Gillnets of 48 and 50 mm mesh sizes made of PA monofilament of 0.60 mm diameter rigged with hanging ratio 0.50 targeted for *Arius* spp. (catfishes) operated from non-motorised gillnetter were the second gear selected. PA multifilament (210×1×2) gillnets having mesh size 14 and 16 mm targeted for white sardine (*Esualosa thoracata*) with hanging ratio 0.53 operated from OBM was the third gear selected. Sampling were done fortnightly throughout the study period on a pre-determined schedule. On the days of observation samples were drawn (maximum 2% of the total catch and minimum 1 kg) from well mixed catch of each selected gear. The quantity of a particular fish caught in selected mesh size on the day of observation was noted. Samples were brought to the laboratory and sorted out to generic and species level and quantity of each species in the sample was recorded to the nearest gram. Total length of each individual species was measured to the nearest mm. The specimens below the length at first maturity were classified as juveniles and those above as adults on particular day(Kamei *et al.* 2013). In the same way, the data for other observation days were also raised and the same procedure was followed to raise it for the month. The method was applied following Sekharan (1962).

RESULTS

The data of species wise landings were pooled together according to target and non target catch in three selected mesh sizes to observe the effect of mesh size on catch characteristics.

OBM gillnetter

Target catch of gillnets with mesh sizes 12 and 14 mm operated by OBM gillnetter was *Escualosa thoracata*. Analysis of the catch of these gillnets showed that altogether seven (7) finfish species were landed by the mesh sizes 12 and 14 mm. On an average target species contributed 56.98% (±7.56) and non target catch 43.02% (±7.31) to the total catch in the gillnets of mesh sizes 12 and 14 mm targeting *E. thoracata*.

Month wise variations showed that the highest target (*E. thoracata*) catch was in March contributing 85% of the total catch with other non target contributing (14.96%) viz. *Strongylura strongylura* (8.42%) and *Hemiramphus dispar* (6.54%) as depicted in Fig. 1. Thereafter, the percentage contribution of target catch had decreased in April with percentage of target catch (41.73%) and non target catch (58.27%) constituted by juvenile of *E. thoracata*(11.01%), *Lepturacanthussavala*(17.185%) and *Trichiurusleptures* (29.58%).The gillnets targeted for *E. thoracata* were not operated in May due to very low landing of target species so data were not collected during May.

In June increasing trend of *E. thoracata*(59.73%) was observed with non target species represented by *H. dispar* (14.46%) and *S. strongylura* (25.81%) contributing 40.27% of the catch. In September, the target catch contributed 41.66% while non target species contributed 58.34% constituted by *L. savala* (26.31%), *T.leptures* (20.03%) and *T. toli* (7.35%). In

November, target catch was 71.97% and non target catch was 28.03% represented by only one species *Sardinellagibbosa*. Again the samples were not available during successive three months viz. December, January and February as the nets of this size were not operated because of lower landings of this particular species in these months.

IBM gillnetter

IBM gillnetters in Cuff Parade landing centre of Mumbai coast operating gillnets of mesh sizes 32 and 34 mm, target oil sardine fishery. Altogether 23 non target species of fin and shell fishes were recorded in gillnets of 32 and 34 mm mesh sizes. Results showed that average contribution of target catch viz. *Sardinella longiceps* was 70.56±9.63% while non target catch contribution was 29.44±6.63% contributed by 24 species

Maximum target catch was observed in January with a contribution of 96.37% to the total catch while non target catch contributed 3.61% constituted by only *Rastrelliger kanagurta*. Least target catch was observed in February with a contribution of 5.07% while non target catch contributed 94.93% of the total catch contributed by *Ilisha megaloptera* (31.61%), *S. gibbosa* (24.39%), *R. kanagurta* (19.05%), *L. savala* (11.26%), *Anodontostoma chacunda* (4.78%), *Pellona ditchela* (1.18%) and *Thryssamystax* (1.67%). In March target catch contributed 27.47% and non target catch 72.96% of the total catch represented by *Ilisha melostoma* (15.48%), *Valamugilsehali* (12.25%), *T. ilisha* (7.64%), *P. ditchela* (6.78%), *Lepturacanthus savala* (6.78%), *R. kanagurta* (5.48%), *A. chacunda* (4.10%), and *Coilia dussumeiri* (1.47%), *Cynoglassus macrostomus*(1.37%), *L. inermis*(4.28%), *Otolithes cuvari* (1.49%), *Terapon puta* (5.66%) and *T. mystax* (5.48%).

In April there was a sharp increase in target catch with a contribution of 94.43% and non target catch contributing only 5.57% (*A.chacunda* 4.97% and *Megalaspis cordyla* 0.60%). In May total target catch recorded was 90% and non target 10% of the total catch constituted by *Ilisha melostoma* (5.20%) and *R. kanagurta*(4.81%) followed by June with 86.79% of target catch and 13.22% of non target catch (9.93% of *I. melastoma* and *T. mystax* 3.29%). In September target catch was observed as 86% and non target catch (14%) which
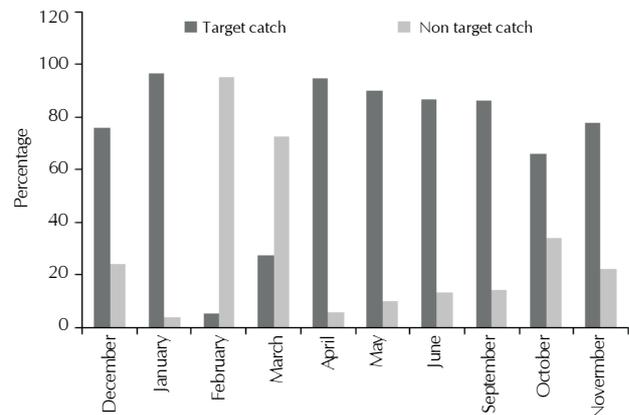

Figure 1: Month wise percentage composition of target (*S. longiceps*) and non target catch in 32 and 34 mm mesh sizes of gillnets
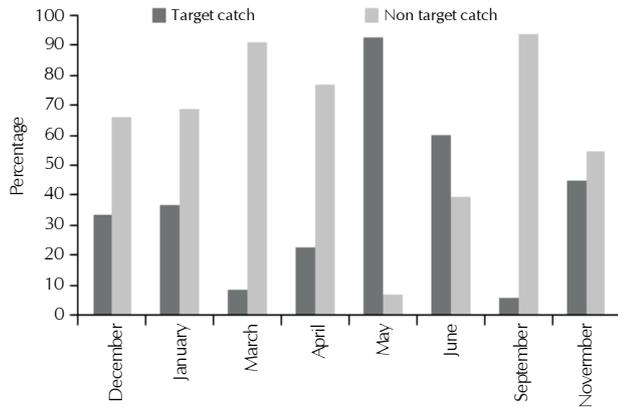
Figure 2: Month wise percentage composition of target (*Arius* spp.)and non targetcatch in 48 and 50 mm mesh sizes of gillnets

Figure 3: Month wise percentage composition of target (*E. thoracata*)and non target catch in 12 and 14 mm mesh sizes of gillnets

was constituted by only *T. mystax*. Target catch observed in October was 66.07% and non target contributed 33.93% to the total catch represented by*Ilishamelastoma*. While of target and non target catch observed in November and December were 77.58% and 75.58% respectively while with non target catch were 12.12 and 24. 42% of the total catch respectively. The non target species in November was represented by *I. melastoma* (10.08%), *Nematolosusnasus* (4.81%) *L. savala*(3.66%) and *T. lepturus* (3.56%) and in December non target catch was constituted by *Thryssa vitrostris* (17.47%), *Eleutherone matetradactylum* (3.46%), *I. melastoma* (1.49%), *Formioniger* (0.65%), *P. indicus* (0.46%), *C. dussumeiri* (0.45%) and *E. thoracata* (0.25%) as shown in Fig. 2

Non-motorised gillnetter

Target catch of gillnets of 48 and 50 mm mesh size operated from non-motorised gillnetter was *Arius* spp. Catch of these nets however comprised of 19 fin and shell fish species. Of the total landings in this gillnet, on an average, the target species contributed $38.38 \pm 8.09\%$ while the non target catch viz., *I. megaloptera,J. vogleri, T. theraps, J. glacus, J. dussumieri,J. balangari, C. arel, C. macrostomus, C. puncticeps, C. orientalis, P. pelagics, P. maculatum,C. dussumeria, R. kanagurta, M.cordyla, L.inermis, O. ruber,P. semiluctosa and* juveniles of *Arius* spp. contributed $61.62 \pm 10.09\%$.

Maximum target catch viz., *Arius* spp. was observed in May with target species contributing 92.87% and non target catch (*Cynoglassusmacrostomus* 6.04%, *Coiliadussumeiria* 0.31% and *Johniusbelangari* 0.79%) contributing 7.14% to the total catch. In June, target species was 60.49% and non target catch was 35.54% of the catch comprising of *C. macrostomus* (2.98%), *Paranibeasemiluctosa* (30.11%), *J. belangari* (2.45%) andjuveniles of *Arius* spp. (3.97 %). During September, whole catch was observed as non target catch with maximum contribution by juvenile of the target species (94.28%) while other species contributed 5.72% comprised of *R. kanagurta* (2.27%) and *M. cordyla* (3.45%). In October, this particular net was not operated because of lower landings of the target species. In November target catch was 44.97% and non target catch 28.03% of the total catch represented by six non target species viz*C. macrostomus* (27.63%), *C. dussumeria* (0.77%),
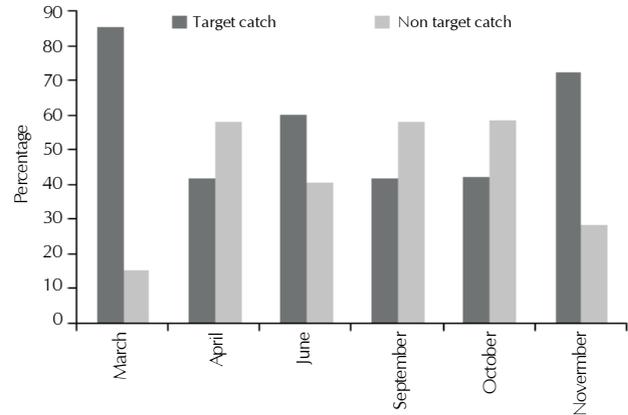
J. belangari(12.24%), *Lagocephalus inermis* (7.28%) and *Charybdis orientalis* (7.11%).

Contribution of target catch was 33.93% while that of non target catch was 66.06% represented by five species of non target catch in December. January contributed 37.17% of target catch and 62.83% of non target species represented by three species viz. *J. dussumieri, J. glacus* and *J. balangari*. Again in February no landing was observed due to less catch of this particular species. A very less quantity of target species was observed in March with only 8.91% contribution to total catch and rest all was contributed by non target catch represented by 9 species depicted in Fig. 3.

Overall status of target and non target catch

A total of 39 fin and shell fish species were recorded in the three selected mesh sizes of gillnets operated along Mumbai coast. Bycatch was significant in the selected mesh sizes contributing 44.69% of the catch. Mesh sizes 32 and 34 mm were observed most efficient for oil sardine fishery as maximum percentage (71%) of target species was recorded in this mesh size and juvenile of the target species was not observed in this mesh size. Only 29% of the total catch was catagorised as non target catch in this gillnet. In gillnets of mesh sizes 12 and 14 mm operated for *E. thoracata*, 57% of the catch was targeted while 43% was non targeted. In this gear, 3.29% of the non target catch was represented by juveniles of the target species. Maximum non target catch (62.32%) was recorded in the gillnets of mesh sizes 48 and 50 mm operated for *Arius* spp. with juveniles of it contributing to 12.28% of the non-target catch.

DISCUSSION

Gillnet is among the most common fishing gear operated in Mumbai coast. Generally catch reporting in the gillnet fisheries focused on the landed rather than total catchtherefore, little information exists on the true composition of the non target catch. The data given in the study indicated that in terms of weight of individuals captured, the target species accounted for the majority of the total catch compared to the non target bycatch except in 48 to 50 mm mesh sizes operated by non-motorised gillnetter. On an average, the highest target catch

was observed in mesh sizes of 32 and 34 mm with 70.56% for oil sardine fishery by OBM gillnets. This was followed by OBM gillnets in using mesh sizes of 12 and 14 mm for *E. thoracata* while the least target catch was estimated in mesh sizes 48 and 50 mm operated for *Arius* spp. by non-motorised gillnetters. Thryssa group was the most abundant non target bycatch in mesh sizes 32 and 34 mm, *Trichiuridae* spp. in mesh sizes of 12 and 14 mm and sciaenids contributed maximum to the total bycatch in mesh sizes of 48 and 50 mm. A total of 39 fin and shell fish varieties were recorded in the three selected gillnets operated along Mumbai coast in which 36 varieties of fish and shell fish were categorized as non target fish. In shell fish group only three species were observed viz., *Penaeus indicus, Charybdis orientalis, and Portunus pelagics* in the selected three mesh sizes.

The main idea behind the fishery regulation is to permit adults to recruit before being caught. During the present study, the juveniles of target species were found to be contributing maximum towards bycatch viz., 12.28% in mesh sizes of 48 and 50 mm operated for *Arius* spp. by non-motorised gillnetter followed by 3.29% in 12 and 14 mm mesh size for *E. thoracata* operated by motorised gillnetter. However, no undersized individual of target species was taken by 32 and 34 mm mesh size operated for oil sardine fishery.

The maximum juveniles of *Arius* spp. caught in the mesh size 48 and 50 mm was probably due to use of small mesh sizes compared to the mesh sizes used elsewhere for the same species. Mesh size of 60 mm was reported to be used for *Arius* spp. in Andhra Pradesh (Ramarao et al.,2002). So the mesh sizes of 48 and 50 mm may not be appropriate as it would not provide effective protection to the *Arius* spp. which had not attained the age at first maturity. It was observed that the mesh sizes used to exploit *E. thoracata* was 12-14 mm while Raje *et al.* (1994) reported that 18-22 mm mesh sizes were commonly used for white sardine fishery in Mumbai coast. This indicates that the presently used mesh sizes are comparative smaller than the mesh sizes used to exploit *E. thoracata* earlier and this may be the reason for maximum juveniles in the catch. However, it has to be specially noted that capture of only adult species in oil sardine fishery in mesh sizes of 32 and 34 indicates that the mesh sizes operated for oil sardine fishery are almost equal to the optimum mesh sizes of 33.4 mm worked out by Joseph and Sebastian (1964) and 34 mm by Thomas and Hridayanathan (2002).

The figures of juvenile bycatch emphasized the destructive action of gillnetting due to use of narrow mesh size on a wider scale in commercial fishing along Mumbai coast. Location of habitat is the important factor associated with the presence or absence of particular species (Burgess *et al.,* 2010). This may be one of the reason for species diversity and percentage of target catch variation in different mesh sizes. The use of multimesh gillnets often results in the capture of juveniles. Luther and Appana (1993) reviewed the size composition of gillnet fishery in various localities of India and indicated that the bulk of the landings comprised of juveniles. Rajagopalan *et al.* (1996) reported that the gillnets accounted for 76.5% of the incidental catch of turtle along the Indian coast during 1985-1995. Luther *et al.* (1994) reported that huge part of the landing comprised of juveniles of lesser sardine in gillnets of

less than 28 mm mesh size and stressed the need to regulate gillnet fishing. *S. gibbosa* caught in gillnets of mesh size 23 mm and below had 100% juveniles, in 28 mm, 73% and practically none in 30 and 32 mm mesh. Podivalai (70-100 mm mesh size) along the Thoothukudi coast land exclusively small sized seerfish resulting in recruitment over fishing (Muthiah et al., 2003). Thomas and Hridayanathan (2003) reported that *R. kanagurta,* caught in mesh sizes 34 mm and below consisted of 100% juveniles while in 36 mm mesh size, 97% and in 38 mm, mesh size 84% % juveniles were caught and in mesh sizes 36 mm, only adults were caught. *S. longiceps* caught in gillnets of 30, 32, 34 and 36 mm mesh sizes consisted of 63, 40, 12 and 3% juveniles whereas *S. commerson* and *M. cordyla* caught in 32 mm were juveniles. Sivakami *et al.* (2003) also reported heavy landings of juveniles of *F. niger* by gillnets of 50-55 mm mesh size to the tune of 25 t from Gujarat coast. Thomas and Hridayanathan (2002) studied the optimum selection of *S. longiceps* caught in PA monofilament gillnets of mesh size ranging from 32 to 40 mm in order to find out the minimum size of mesh to be used to prevent capture of fishes below the size at first maturity. The study showed that mesh sizes below 34 mm could not protect the resources as it caught fishes which had not attained the stage of first maturity. In the present study, it was observed that in March, maximum target catch was recorded in gillnets having mesh sizes 12 and 14 mm mesh sizes operated by OBM. In case of IBM gillnets of mesh size of 32 and 34 mm maximum target catch was observed in April and in non-motorised gillnets of mesh size 48 and 50 mm maximum target catch was observed in May.

Gillnets are size selective and not species specific thus non target catch is associated with the target catch (Hamley, 1975). The study location viz., Mumbai coast represents multi-species fishery. Hence landing of non target catch in gillnets having optimum mesh size for a particular species is unavoidable. So increase of mesh size will increase the selection factors therefore, retention of juvenile fishes could be considerably reduced. The quick release of non target species back to sea may also help in reducing their level of mortality (Alsayes et al.,2009). Declaration of certain coastal areas as closed for fishing especially during breeding period where the abundance of juvenile is high would also help in reducing the amount of non target catch as well as conservation of the marine ecosystem of Mumbai coast.

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